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Increasing public skepticism in the face of imminent dangers from climate change: A call for science to repair rifts between society and academia

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Introduction

This project is a composition of a literature review, our learning process, and an attached experimental project. The project sought to understood how and why policies/corporations resist environmentally sustainable practices/laws and makes suggestions for how to convince people to change their behaviors and utilize their power as consumers.

Overall, the goal of this project was to investigate and understand the relationship between science and the public by composing a literature review of environmental science, sociology, and psychology papers, and then compose a presentation that would communicate the threat of climate change. The interdisciplinary nature of climate change made this research necessary because prior to this project, we understood climate change solely on a scientific level, without fully understanding the other spheres involved in environmental science. The literature review outlines instances of when environmental science has effectively engaged non-scientists and other areas of the field that have failed to connect to the public. The subsequent sections and text explain our thought process and our attempts to begin addressing the public successfully and creatively.

The literature review is followed by our methodology. The literature review enhanced our understanding of climate change, its communication, as well as the interdisciplinary subject of environmental science. The methodology explains our entire timeline and project progression, calculations of greenhouse emissions, our ice melting experiment, and our infographic. This section is followed by our results and then our

discussion, where we talked about what we thought of our project's progression and what we learned throughout the process, as well as elaborate on how the project was limited by time constraints. The discussion is as much an interpretation of the results as it is a criticism of the methods taken to get said results.

Literature Review

Science and Society

Science is a discipline focused on acquisition of knowledge. Those who use and apply this knowledge can either be members of the scientific community or other members of society that utilize facets of research. Science provides information, but this information can sometimes be warped through the lack of accessibility to the public. Like distorted images underwater, scientific facts can be manipulated by inaccurate reporting or pre-existing biases. To understand science's role in society, one must understand the multifaceted interface between science and society. Science is connected to society with media as its main liaison. The news media is a useful tool to communicate scientific findings, but it forces science to rely on external influences to educate the public rather than educating the public directly.

Without media reporting responsibly on scientific issues, many citizens will remain ignorant of the vast amount of new information being discovered by scientific studies and their potential consequences. Furthermore, many of the scientific findings that should be disseminated to the public remain housed in databases and journals that require pricey subscriptions. Access to information, specifically information that would be beneficial to human health and well-being, should be available to the public without financial barriers (Rother, 2014). Because of this, most of the information that is critical and threatening to individuals remains cerebral rather than being made accessible to the public or to local law-making bodies. This prevents action from being taken (Rother,

2014). This remains the issue because direct communication between scientists and the public is rare.

It is even rarer to find meaningful, two-way conversation between scientists and the public. Two-way communication allows the public to engage with science and to ask questions, rather than being spoon-fed information. A two-way communication model allows scientists to answer questions of the public, rather than leaving the public to speculate about their own questions, and oftentimes, drawing the wrong conclusion (Rother, 2014). There is an optimistic assumption that speech situations concerning scientific communication will be ideal and that the audiences will understand what is being communicated. This assumption can be confirmed or denied based on how scientists present their work. If the lay audience isn't given opportunity to give feedback on the presentation, the scientists will remain ignorant on how well their research was understood by the target audience (Rother, 2014). That being said, science's role in society at this moment is complicated.

Science wants to do as science has always done, stay neutral, provide information, and acquire more information. However, science faces increasing social, political and economic pressures from outside of its own discipline. It is necessary for scientists to have a background in these disciplines: "We argue that for scientists and science communicators to build usable knowledge for various publics, they require social and political capital, skills in boundary work, and ethical acuity" (Leith and Vanclay, 2015). For these reasons, perhaps it is reasonable to expect that scientists should be trained in social, political and ethical dimensions before they are considered scientists. Checkmarks should exist in post-secondary, scientific education that requires

aspiring scientists to be educated in the sociopolitical realm (Leith and Vanclay, 2015). Having an understanding of the complete system will allow for more effective scientific communication.

In our society, communication has become globalized and instanaeous. Because of this, communication has become even more important. The utility and ubiquity of communication across our planet has been used to promote consumer culture in the face of mounting evidence of the looming threat posed by climate change. These phenomena are at odds with one another. Science can use the power of digitized communication to edify the public on climate change. With this potential power, science must overcome the lure of present-day capitalism which endangers the environment.

In order for science to ever make any lasting statements against our current system of capitalism, science needs to connect with individual populations to reestablish their faith in scientific discovery. A good method for engaging the public regarding scientific issues is to get them involved and show how they're invested in the particular issue. For example, Queensland agro-climatologist, Roger Stone, has invested himself into the community. He has communicated climate science with farmers over years of interaction. He sets up risk management profiles that prime farmers to be aware of the weather. It makes them aware of the situation, and instead of being reactionary, the farmers become proactive in the face of climate changes. They claim ownership of the information and start educating themselves on climate patterns (Leith and Vanclay, 2015). The efforts that this scientist has taken to engage farmers in scientific research is important. It is unlikely that this audience would have participated in science on this

level without his intervention. More importantly, the scientist made climate science relevant to these farmers.

The types of scientific discovery that come in contact with society is science that is salient and legitimate. Saliency is defined as the prominence and relevance amongst local populations on how recent scientific information/knowledge affects specific actions Legitimacy is defined as an assurance that the research done is inclusive of everyone that it affects. There is a significant effort to cover the different disciplines involved in the research (Leith and Vanclay, 2015). The communication of scientific principles to the public depends on the connection of science to public interest. People don't wish to learn new things if they're not interested in it or affected by it (Maher, 2016). Therefore, environmental science needs to connect its research more with the public and become more salient and legitimate. Climate change research is obviously important, but has thus far fallen flat with regard to connecting its relevance to a majority of local populations.

In the eyes of the public, scientists also struggle to discuss their information and findings without making a debacle out of it. Scientists can permanently damage each other's relationships in public, undermining the field's credibility in the public eye as a whole. Contests of credibility, although necessary in science because of the non-definitive nature of most scientific discoveries, should be left out of the public eye. Increasing questions of credibility and concern over what constitutes legitimate scientific fact can create a distrust in science, with people not knowing what to believe (Wynne, 2006). This discourse does provide more accurate results, but it should be kept hidden from those who are already skeptical and not aware of the full scientific process.

Although science's main access point to society is through media, scientists have been attempting to develop other ways to communicate to the public. This may be because of how the relationship between media and science has been warping the perception of scientific discovery for quite some time. The alienating view of the scientific enterprise has aroused speculation and doubt in the public concerning the nature of science.

The public's skepticism of science isn't derogative. It is completely natural and understandable given either their lack of training in the scientific method or the sketchy connections of scientists' research to big business.

> ...These doubters are not anti-knowledge; they are not anti-science... They question whether the science that is getting pushed is trustworthy, whether it is really the result of the good-faith pursuit of knowledge rather than the ambitious drive to secure patents, for example. (Noë, 2017).

Society has become increasingly aware of the interactions between science and industry. Because of this, science must distance itself or recognize the difference between science for the sake of knowledge and science that has a predetermined goal. Big science is the field of science involved with making findings that benefit certain products or companies. In the age of recent technological advancement, society seems to have forgotten science's role as a discoverer, a field that primarily focuses on acquiring knowledge, rather than a field that is used for economic and technological gain (Wynne, 2006). There is a fine line between making money off of innovation and pushing science to its limits to acquire more profit.

Big business connections and a lack of explanation by scientists especially causes problems because of a lack of access to information. Scientists have made strides in making information more accessible to the public. However, online scientific journals still fall short with regards to their widespread availability to the general public. Often times, without subscriptions or access via university networks, individuals cannot access these journal articles and scientific studies (Kling and McKim, 2000). Preventing society from having access to the information that could potentially help govern them is risky and sends the message that they are absolved of academics and cannot understand information.

In efforts to push forward with scientific discovery, it is quite possible that the academics that govern these secured journals have left society behind in the zest for knowledge. Science cannot merely afford to hoard knowledge without dispensing it to society. In that situation, we become aware of problems discovered through the efforts of science and then proceed to do nothing with the information because the information is trapped within the scientific community. It is difficult for science to communicate to the public because science has lost public trust and legitimacy due to increasing strains on public credulity and an intense and extensive dependency by the public on “scientific innovation”. Science has also been discredited in the public’s eye because of its willfulness to ignore their fears and mistrust of science, ignoring concerns that may be based on reasonable questions, assuming that the public is ignorant and does not understand. Science precludes itself from acceptance by society through the method of assuming that the general member of society is too ignorant to participate in scientific

discussion (Wynne, 2006). An effort to combat this may be by involving citizenry in scientific discovery.

The Netherlands has had a problem with water resource management and awareness amongst their citizens regarding these issues. This has lead to Dutch citizens making decisions that endanger the Netherlands' excellent water quality. Despite the Netherlands' expert water resource management, there is a significant awareness gap amongst Dutch citizens when it comes to water management functions. This awareness gap is propagated by the lack of major water calamities in the past 60 years as well as improved water quality over the past few decades. This has caused citizens to take the water resource management for granted. For this reason, citizens have behavior that counters the efforts of water authorities. Consequently, citizens are not aware of water threats, which causes a decrease in support for water quality management. In order to combat this ignorance, the Dutch have employed citizen science to get their society more involved. Its goal is to contribute to data collection and enhance monitoring programs. By doing so, it will involve citizens in the process of water resource management so that they have an understanding of its elements and no longer take it for granted (Minkman, 2017). Citizen science offers the public the opportunity to engage with science given a lack of specific knowledge.

This new way of involving the public in science allows for regular individuals to learn more about the world around them. While there can be doubts given their lack of technical expertise, they can be utilized for simple processes such as data collection. If people can be empowered to enjoy the process of science, the barrier between science and society will begin to wane. Scientists, however, should be aware of the friction

created when interacting with non-technical individuals. Issues that can arise are, regular citizens having an issue with long-term participation, scientists creating a power hierarchy given their expertise, and volunteers having a dissatisfaction with the research process (Minkman, 2017). Citizen science is not a foolproof plan to promote scientific understanding in American society. However, it is quite possible that it could be the start of a long road towards bridging the gap that exists between our current citizenry and our scientists.

The goal of a scientist is to combat ignorance through the acquisition of observational and experimentally-based knowledge. Scientists can make impressions on ignorance on a local level through discovery. However if they fail to communicate these findings with public society, people as a whole remain ignorant. Issues arise because a majority of science cannot fully interact with the public face-to-face. Unlike lawyers or doctors, there exists a lack of one-on-one and trust formed from the connections that allow for people to accept new information (Merton, 1942). Therefore, scientists are unable to correct the ignorance that exists within communities. And while some research findings may seem obvious to some populations, it may seem like an abstraction to others.

In some smaller communities, traditional, cultural stories and ideologies persist. These cultural values prevent the acquisition of scientific knowledge on local levels, as science generally goes against their ideological base and understanding of the world (Klein, 2011). Scientists often times leave the general public out of their process and out of their findings. Therefore, it is difficult for science to combat ignorance where it can, because scientists do not have any sort of liaison exclusively within the scientific

community to communicate information to the lay public. As such, ignorance ramps up without being combatted by those who have the scientific clout to do so. Overall, there is a barrier here that science must commit itself to breaking. If ignorance is left unchallenged, it gains traction in communities through misguided followers. Science must prioritize this threat to both scientific discovery and society itself (Merton, 1942).

Barriers to Scientific Communication

The barriers that stop science from being communicated accurately are sociocultural as well as political and economic. A particularly frustrating interaction between science and policy has emerged. There is a block between policy formation and scientific discovery. The insufficient use of existing scientific knowledge is blamed on the research community. Users of the information blame researchers for not working on "relevant projects." Researchers tend to criticize the user community, blaming the lack of action on clients' misunderstanding of scientific information (Janse, 2008). Policy's failure to adapt to scientific discovery has placed scrutiny on both politicians and scientists alike. Both of these groups have pinned blame on the others for the shortcoming of their interactions (Newman, et. al, 2016). This is one example of how science's role in society cannot be fully realized until it learns to cope with the barriers that exist in communicating scientific information.

Another barrier that prevents effective scientific communication would be the role of the media in communication. These barriers exist by nature of the conflict of interests existing in the interactions between science and policy; as well as the interactions between science and media.

The interaction of science and media is a relationship that is evolving dramatically as we move into an age where information is readily available and communicable. Science has a history of being slow to latch onto new communication

methods. In the past when papers were digitized, scientists would not consider them legitimate if they didn't have an original, paper journal version. However, scientists must have their work scrutinized before being published, regardless of format. This ensures that the electronic copy will hold up to the same rigor as its physical copy. This lends credence to the validity of scientific papers that have been put online (Kling and McKim, 2000). If science does not rise to the occasion of providing information in an accessible form, our society and media may latch onto conclusions that lack any scientific backing. Science is making attempts to adapt to the globalized and information-dense society that we now live in. Along with the rise in electronic media to support scientific communication, science is seeing other major shifts in this era. The rise of global science and the increasing stress on the biomedical sciences are also major shifts in the science system. Electronic communication trends have also expedited and enabled international studies between scientists who work globally. As time passes, science will begin to completely transition to digitally based information, communication, and research sharing that will allow for more fluidity in the format of scientific communication (Kling and McKim, 2000). It is necessary for science to utilize this increased ease of communication to communicate not only to scientific peers, but to society at large.

Media's interaction with science is necessary as science itself is not going to promote its discoveries. Mass media is the main form of communication for a large majority of the population. It holds a monopoly on sources of information. For this reason, there exists an opportunity for scientists to utilize this method of communication (Walter, 1987). However, the interaction needs to be appropriate. Oftentimes, scientific discoveries can be warped by the media when the media attempts to make science look

more interesting/appealing to the public. This misrepresentation of discoveries has trickle down effects for both media and science as a whole.

Scientists and the media both have a stake in informing the public on recent scientific findings. They are obligated to present the information in a clear and accurate manner while also keeping it interesting. Good reporting of science has the potential to generate interest in the public which will exert pressure on the government to increase research funding. If a scientist cannot reveal all the information on hand (either because it is preliminary or because it infringes on the privacy of individuals under the study), she/he needs to be willing to divulge the information that they can, which is often enough to make a useful media report (Walter, 1987). Scientists have a habit of withholding information until they can completely explain their findings. Because of this, when scientists don't know everything about an issue yet, they withhold the information. This spawns a delay in conversation between science and media which then causes communication between science and society to become stagnant. As a result, the media tends to rely on information from unreliable sources, due to their need for headlines, causing the propagation of false information (Walter, 1987). In order for scientists to make connections to society, scientists need to establish a context in which their research is accurately portrayed to the public and localities, and making it understandable within the context of the common populace.

Given the errors associated with scientific reporting, scientists need to be more available to reporters. By being more available, accuracy of information can be ensured (Walter, 1987). Despite what should be similar interests in getting scientific information publicized, media and scientists operate on radically different timetables, and as such,

they have different needs. Because of this, the reporting of science occurs in such a way that is not ideal for the scientific community. The opposing goals of scientists and journalists have resulted in a tension between these two groups which strains how scientific information is relayed to the public. Journalists seek to dramatize research and create bombastic headlines, making discoveries seem extraordinary, when in actuality they're usually less exciting. This creates problems as scientific progress is not one single event, but rather a continual storyline. By doing so, science seems like a collection of discrete developments rather than a continuous arc. Furthermore, journalists are driven by a theory of objectivity that revolves around the idea that truth comes from a balanced story. They seek to show everyone's perspective. Scientists believe that truth comes from legitimate evidence and those with credibility, causing them to disregard the idea of a balanced story. Scientists would find issue with the journalist's theory of objectivity, because it values perspectives equally, despite academic standing or scientific background. A scientist would be compelled to ask why someone without a scientific background has any grounding in scientific matters (Nelkin, 1987). While this may come across as condescending, it is not. Science should not be governed or influenced by opinions of those not trained in the respective fields.

Journalists who cover scientific issues are tasked with two difficult issues. One, they must understand the research/findings presented to them, and two, they must break down the results of the findings so that it is simple and interesting to an audience. Journalists must simplify science, so that the public can better understand their news coverage. This action makes it able to be understood by a wider audience, but it comes with a major pitfall. This simplification of research by journalists often disregards

precautionary elements, documentation of data, and important information that scientists point out in their publications. Intentional or not, these elements are important with regard to research dissemination. By not covering the research adequately, the findings become misconstrued and inaccuracies are propagated to the public. These inaccuracies ignore several “fine print” facets of academia in favor of highlighting dramatic scenarios/results from a scientist’s research. “When scientists attempt to use the press to promote their work and science reporters rely more on imagery than on substance, the public ends up with an idealized and alienating view of the scientific enterprise” (Nelkin, 1987). This dramatization is then later revealed to be a falsehood, causing society to distrust scientists when it was the media that reported inaccurately.

The complicated relationship between media and science needs to be transformed if it is to be a mutually beneficial one. The true purpose of scientific journalism lies in creating an informed citizenry. Proceeding forward with this mission for scientific journalism requires that scientists become more socially competent, both with the media and the general public, the media needs to use more resources to accurately represent scientific research, and the two entities need to recognize their interdependence. The media and scientific community must work together to diminish scientific ignorance and propagate new scientific findings (Nelkin, 1987). The assumption that science and society are entirely separate dimensions has led to the conclusion that society needs to be consistently updated on what science does, when in fact society and science are heavily interdependent and develop together. It follows then, that scientific knowledge and non-scientific knowledge do not develop separately but instead they are part of a continuous interaction between experts and non-experts.

This knowledge is called non-specialized knowledge or interactive science. Media's function should be to play an intermediate role in linking scientists with the public to produce this interactive science (Maher, et. al, 2015).

Social media is another emergent force that is gaining traction for communicating all information, and it's possible that social media can also act as a powerful force to spawn two-way communication between scientists in their own communities as well as between scientists and the public. Social media continues to enlist millions of people as it gains global popularity. The number of people using social media continues to increase, with internet content constantly being uploaded. Social media is becoming a revolutionary trend, even gaining traction amongst older generations that may have previously balked at increasing interactions with technology. It has created an operating space for information, corporate actions, and individuals to interact (Kaplan and Haenlein, 2010). The theory that attempts to describe how social media affects individuals is called social presence. It is defined as the acoustic and visual contact between two communication partners. Social presence is influenced by the intimacy and immediacy of the medium. In tandem with this theory is the concept of media richness, which is based on the idea that the goal of communication is to resolve ambiguity and promote clarity. Media differ in the degree of richness possessed. Some media are more effective than others in promoting clarity (Collins et. al, 2016). Specifically, social media provides a wide spectrum of effectiveness when it comes to providing information and promoting clarity.

Social media's role in communicating information has led certain websites to the conclusion that their increased communication may also be spreading misinformation.

Social media can be used as a tool to obscure, as well as enlighten. Facebook has taken small precautions to control the quality of information that is shared through their services. Given Facebook's unique ability to act as a source of sharing information, it has become a news source for certain people. Its utility has been used to spread information that has merit as well as falsehoods.

Fake news sites appear no differently in users' feeds than legitimate news sites. This created issues up until the development of Facebook's "walled garden" which attempts to weed out these false news sites. While Facebook is making strides to remove false information, these sites/posts still exist. What makes it even more dangerous is the fact that this information is shared amongst close friends and family. This generally prevents people from fact checking their information because it's from someone they trust. Furthermore, Facebook is hesitant to act as a "gatekeeper of information" because of the issue of partisanship and bias. Filtering of information/posts is hard to do without a general bias, as humans are inherently biased. (Collins et. al, 2016). Facebook and other social media that attempt to engage in quality control of their media have a difficult prospect ahead of them. They seek to promote legitimacy, while also avoiding polarization. Overall, social media adds in another difficult filter for scientists to navigate.

Creative avenues for educating the public have arisen over the past decades, including blogs, citizen-science journalism, and other web-based tools. These avenues allow scientists to directly interact with the public and respond to false claims made by erroneous sources. However, despite this golden age of information, there exists a counter problem. Scientists can only counter erroneous information so much, and with a

vast expanse of knowledge (true or false), it becomes increasingly harder to educate the public with actual facts (Groffman, et. al, 2010). If scientists begin to work on the education of environmental science, then scientists will have to do less work on countering false information, because the public will understand the difference between accurate and inaccurate science.

It is becoming evident that environmental science is becoming a subject that requires interdisciplinary collaboration. Like most disciplines, it will require participation from the social, life, and physical sciences. Education must be unique and creative, involving non-traditional educational resources, such as social media and interpersonal communication. People learn values and beliefs more from their friends and family, as well as media sources, than from the traditional teaching atmosphere

The vast majority of scientists are in agreement about the threat posed by climate change. Despite it being such a problem, there is no mandatory science curriculum in the K-12 system that educates American children on the issue. In fact, in most cases, public education fails to address or even recognize the issue of climate change. It would appear that the school system is flawed and needs to align itself more with current scientific issues (Hofstein, 1982). If schools are failing to provide children with the scientific knowledge that they need, the onus then falls on parents. The scientific education of younger individuals may be hampered by the conditions provided by their parents. Parents that are willfully ignorant on scientific fact, or parents that don't know any better may end up slowing down the scientific knowledge of their children. This issue is not self-rectifying as it gets harder to change with time and it repeats itself generationally based on family upbringing and values (Solomon, 1993). This issue must

be addressed--and if it will not be addressed by our educational system or parental units, perhaps scientists need to make efforts on influencing scientific education. If scientists want their research and data to result in actual transformative change that helps us mitigate this ongoing environmental crisis, they are going to have to work outside of their comfort zone and engage society to challenge their cultural beliefs.

It is necessary that scientists work to engage the public. In doing so, they must take into account a variety of factors. Scientists must understand what drives the public, whether that be religion, access to a job, or health issues that will arise from said environmental problems, and use those factors in communicating the risks of climate change (Groffman, et. al, 2010). Without this gap bridged, many people will miss out on the gravity of climate change and how it can affect us in the next few years. Climate change experts must develop ways to communicate their findings with non-experts. For instance, many people do not consider the importance of ecology because they have not had meaningful contact with scientists, let alone an ecologist. Ecologists are critical in our society's understanding of climate change. Their research, along with other climate change experts, should be disseminated across the lay audience.

> In particular, ecologists must make greater efforts to reach non-scientific audiences and need to think more deeply about the social networks that influence these audiences (Groffman, et. al, 2010).

The good news is, despite the lack of action on political fronts regarding climate change, many Americans do believe in the validity of scientific experts. Americans, for the most part, still believe scientists have a better understanding of topics such as climate change, and because they believe they have a better understanding of these

topics, many Americans believe that scientists should have a greater say in policy decisions that affect the environment. However, there exists a gap between what Americans believe to be true and necessary, and what actually happens within the political atmosphere (Groffman, et. al, 2010). Furthermore, the way that scientific professionals educate individuals shapes how the information they present is perceived. Educating individuals with the perception that they're ignorant creates an atmosphere of condescension, which may prevent the public from uptaking valuable information. A better alternative would be to relate scientific issues and problems to these individuals and convince them of their role in promoting the health of the environment and by extension their environmental health (Groffman, et. al, 2010). Environmental research has resulted in several scientific findings that have convinced most scientists and some citizens on the urgency of climate change. Despite this, political action remains static on how best to resolve this current crisis.

As an example, tightened laws and environmental restrictions on businesses could play a significant role in reducing the amount of greenhouse gases produced by humanity, which would slow the ever-increasing pace of climate change. However, these policies have yet to be enacted despite scientific findings. The delay between scientific discovery and political action is a result of the fact that the relationship between academics and policy is an intertwined one. The interface between science and policy is a dynamic boundary constructed by scientists and policy makers attempting to balance three tensions. These tensions are maintenance of scientific credibility, insurance of practical saliency, and legitimization of the process to multiple participants. To make matters even more complicated, conflicting scientific evidence

can create issues with policy development. This can be attributed to the fact that a number of scientific models can often times exaggerate conclusions for policy development. Furthermore, conflicting science based in partisan behavior can confuse the development of policy. Likewise, scientific information can conflict with the political need to agree on a policy. For this reason, research has become too loosely connected to making political decisions. Because of this, research is done, but those who make decisions don't use all of the information available. Also, advocates of contrary opinions struggle against each other, using their policy related research as evidence against each other, impeding the progress of policy (Janse, 2008).

Despite belonging to separate communities, scientists and policymakers should interact frequently in a two-way communication system. However, currently at the moment, this two-way communication system is absent. Academics are consulted for their research and then that research is given to the decision makers. This allows for a lot of misunderstandings and warping of information to be done by politicians. This could be minimized by conversations surrounding the research but there's a lot of different interaction between the two groups. In order to allow these two groups to work together more appropriately, they need to work on making communication between the two of them more fluid and dynamic. There exists a wide spectrum for how research is used by policy-makers. These policy makers can either ignore the findings of research when making policy, or they can value the said research for the purpose of policy making. Use of academic research within policy settings, and the attitudes towards its use, has a wide degree of variance. The interaction between academia and policy exists on a continuum of interaction. There are some public servants with heavy engagement

with academic research, and those who are not engaged with research at all (Newman, et. al, 2016). This variability in the engagement between academics and policy makers leads to policy makers who understand scientific discoveries more than others, which causes friction and gridlock between policy makers in legislative bodies.

Scientists' reluctance to participate in politics has been detrimental to the implementation of science in policy. Scientists in the past have avoided political interaction in favor of keeping science "pure" rather than partisan. It is this hesitation to enter the political field that has doomed science to become partisan. If scientists understood the political process and had a willingness to engage with policy, as well as an ability to engage the public, it would allow scientific discoveries to be discussed in a political format without being distorted by either political party. The partisan interactions between science and politicians can be minimized by scientists that present findings to political bodies directly (Janse, 2008). The hesitation of scientists to participate in politics is a logical hesitation. However, if they continue to balk, their work will continue to be misinterpreted.

Scientists have a desire to keep science "pure." However, sometimes industry hires researchers to do research that results in making their product look safer or better than it actual is. This intersection between science and industry is called "Big Science". Big science is this entity formed between the interaction of industry and scientific research. It's science with a conflict of interest. It doesn't have an interest in merely furthering knowledge, but rather, it has an agenda. An example of this conflict of interest is how Exxon funded research in climate change despite the fact that Exxon has a clear stake in making climate change look less serious than it is. Because research is

sometimes conducted by “big science,” there are seeds of mistrust sown amongst the populace. Science will always have some level of corruption in it due to the human factor. Science can combat this mistrust by recognizing and reflecting on their intrusions of corruption and making amends to the public (Noë, 2017). Industry’s interaction with science delays the relay of correct information from scientists to the public. For instance, many industries see accurate climate change reporting as a threat to their well-being as it will cause consumers to stop supporting their industry. For this reason, climate change science and research is seen as a threat to our capitalist society as a whole. However, the crisis of climate change and its widespread denial will ultimately be more damaging to our capitalism than any other force.

Climate Change Communication

In a modern context, science must embrace society in a two-way conversation. It is no longer appropriate to have reliable knowledge that is presented in a lecture style or knowledge that citizens don't get to engage and have feedback with. In order to communicate global environmental change research, there needs to be a greater understanding on the part of researchers that the audience that they are engaging is not uniform in ideology. Engaging them is going to require a more contextual approach than engaging scientific peers. Translating science to a format that is more readily understood by society is a must (Weischelgartner and Kasperson, 2010). In other words, education extends beyond informing, which is what most scientists do for society in this day and age. Education of lay people takes time and effort. When informing alone occurs, it can often be difficult to convince people to take action. This can be seen in the information/knowledge we have on incoming natural disasters that are brought to us from meteorologists.

The prevalence of natural disasters and the information they yield for prevention and mitigation, combined with an existing knowledge base coming from research creates opportunities for more effective action. However, information is currently not being used appropriately and communities need to have a better understanding of available knowledge. And while the prevalence of natural disasters would theoretically yield more understanding, communities fail to integrate this knowledge into wider efforts for sustainable development and preparation in general. The dynamic between humanity and the environment is undergoing a rapid change and because of that

change, it is necessary that humans adapt to these changing conditions. Understanding response mechanisms of society and science is a critical issue. Natural risk management has increasingly involved scientists and practitioners from various fields, but despite this increase in knowledge, environmental crises are continuing to rise in intensity. This stems from two possible problems, either the existing knowledge is not adequate despite the increasing research, or the existing knowledge is not being used effectively (Weischelgartner and Kasperson, 2010). It is quite possible that our progress as a society may be further hindered despite scientific research because of our society's separation from science.

Scientists are understandably hesitant to translate their work to lay audiences. There is a degree of understanding that is missing from lay people when discussing complex scientific issues, and some important details cannot be translated to lay audiences. While traditional lectures put emphasis on finer details and complete description of scientific discovery, the attention to detail sacrifices the understanding of the public audience. A dialogue, rather than a lecture, allows and invites the lay audience to participate in science instead of spectating (Arts et. al, 2016). The hesitance of scientists to engage lay audiences is one that academic professionals will have to acknowledge and move beyond. If scientists do not move in to fill the vacuum left by lack of information, lay audiences will be left to draw their own assumptions from non-scientific sources. Research should be conducted on how to effectively impact lay audiences, rather than labeling skeptics as "climate change deniers" and ignoring their influence on others. Environmentalists must turn to sociological and psychological research if they are to become effective climate change communicators. When

discussing climate change, it's important that you don't marginalize groups and include a positive frame of communication. The scientific community needs to shy away from the term "denier" and create a more understanding approach for engaging those that are skeptical. By doing so, there exists space for constructive conversation, allowing for topics pertinent to the individual to be discussed. For example, explaining how climate change can affect public health and how it could possibly negatively affect individual health. Tying the issues into self-interest gives a personal spin to problems, as well as a way for individuals to understand it within their worldview (Urry, 2016). Understanding that people learn values and beliefs more from their friends and family, as well as media sources, than from the traditional teaching atmosphere is pivotal to a successful education on environmental issues (Groffman et. al, 2010).

The type of "crisis" that environmental scientists are concerned about is one that affects us all as a humanity. For this reason, the risks are significant, and they must be communicated in a way that is effective and multifaceted. This is not a branch of science that can serve humanity well without good and successful communication.

> In order for environmental communication to be successful, it must understand how the dynamics of digitization, globalization and intensified consumerism have intersected with the climate crisis. It must investigate how inequality of access and power structures constraining communication resources have altered debates and decision making on climate change. Climate change communicators must understand the different cultural, socio-economic and political contexts that generate constraint or silence around media discourses centered on climate change (Brevini, 2016).

One significant way in how some scientists have failed to effectively communicate climate change is how they have alienated themselves from society by failing to recognize the good that fossil fuels have done for our society. When scientists label fossil fuel as purely evil without recognizing the lifestyles and needs of those who are outside the divest movement, they do themselves a disservice. Because many people are still reliant on fossil fuels, climate change communicators cannot afford to alienate themselves, because it is possible (and likely) that the general public will align themselves with those out of the divest movement. By understanding the needs of those reliant on fossil fuels, scientists can communicate to them a future that meets their needs without relying on fossil fuels, and the new economic opportunities that a future without them can provide. Environmentalism needs to be a radical movement, but it cannot afford to be radical and exclusive. An inclusive and radical movement has the power to transform our nation's reliance on fossil fuels. Confusions around how exactly fossil fuel based energy operates and how it contributes to climate change is another failure on the communication of climate change. Similar to climate change, the current, non-sustainable energy system and how its pollution and consequences affect our world is abstract and difficult to understand. The effects and impacts of our fossil fuel reliance as well as the effects and impacts of climate change is an abstraction at best to the lay audience (Corner and Clarke, 2016). The repeated conversations surrounding climate change are largely academic and cerebral. This leaves out a significant portion of the populace, and as they continue to hear science about climate change they grow more and more skeptical because it is not affecting them directly, and they aren't seeing any

of the local effects in their area. The repeated topics of climate change with no local changes causes a “climate fatigue”, a sensation that causes people to grow more skeptical of climate change rather than support it (Corner and Clarke, 2016).

On the other hand, communicating a threat to society without giving them hope or ideas on how to combat the threat leads to paralysis. The threat needs to be communicated as well as strategies on how society can combat and contribute to the fight against climate change. The most effective way to convince people on the actions necessary for them to take is to connect climate change to the threat it plays to society’s public health (Corner and Clarke, 2016). The responsible and effective communication of climate change has the potential to influence some people who are undecided and even some climate change skeptics. As the climate change movement gains support in society, it is likely that climate change will be taken more seriously by politicians, and policies targeting the reduction of climate change will be supported.

Environmentalism and Society

It is difficult to track environmentalism down to one specific point of origin, as many ancient civilizations took part in what would be considered today as environmentally conscious, or sustainable practices. However, modern environmentalism, which protested industrialization and the degradation of the environment, is much more heard about. And while a definitive beginning cannot be attributed to such a large, multi-faceted movement, the publication of *Silent Spring* by Rachel Carson has often been associated with the onset of the modern environmental movement. The book details the effects of DDT on ecosystems. It lays out her beliefs (backed by scientific evidence) that if pesticides containing chemicals such as DDT were to be continually used, there would come a time when spring would roll around, birds would no longer chirp, and life would cease to exist (Carson, 1962). Originally discredited, her book inevitably gained popularity and momentum amongst environmentalists and is believed to have provided the necessary foundation for the banning of DDT and other harmful pesticides.

Despite the rise in modern environmentalism after Carson's plea for the eradication of DDT and the group's identification with the general idea that we need to protect our environment, the environmentalism movement seemed to split off into many different groups; each with different agendas, motives, and perspectives. Today, environmentalism is an umbrella term for an amorphous group that has a variety of different perspectives. For example, some common environmental mindsets include wildlife management, conservation, environmental justice, ecofeminism, and the most

common, reform environmentalism. Reform environmentalism preaches that natural systems are the basis of all organic existence, and that human health and survival is tied to those natural systems (Brulle, 2009). Basically, human health is dependent on the natural systems that humans are a part of and the health of the natural systems are governed by their actions/behaviors.

Regardless of the perspective, it seems as though a majority of individuals have been persuaded that they have a large, individualistic role in protecting and "saving" the environment. Our culture as a whole has focused on individual waste where the environment is concerned. The phrase, "reduce, reuse, recycle, and you'll help save the planet," is one preached by several entities like the Environmental Protection Agency, colleges like Columbia, and the municipal departments such as the New York Department of Environmental Conservation. However, individuals as a whole do not make a dent in large environmental problems. For example, when it comes to waste and the behaviors targeted by "reduce, reuse, recycle," individuals are barely scratching the surface when correcting solely their own individual behavior. The most recent study comparing municipal (individuals within a municipality) waste to industrial waste was published in 1987 and acts as a reference to this day. Not only is it alarming because of how old the study is and how much more exaggerated it probably is now, but in 1987, there was an industrial 7.6 billion tons of waste compared to a municipal waste of 250 million tons (MacBride, 2014). That's 96.8 % of waste produced by corporations rather than by municipal populations. This would suggest that while individuals do play a minor role in 'saving' the environment, further efforts on minimizing our impact on the

environment should perhaps focus on corporate waste production rather than the individual, due to the staggering disparity between municipal and corporate waste.

To make matters worse, a number of “environmentally conscious” behaviors are in fact not what they seem. For example, it seems that the process of recycling, a system that has been championed in society as being sustainable/environmentally friendly, has major issues. For starters, a majority of plastics cannot actually be recycled. If you look at the bottom of any plastic container, you’ll see the recyclable symbol surrounding a number. Most recycling facilities can only handle 1 or 2; even though there are 7. Putting these containers in the same bin creates issues for the recycling facility, as the numbers correspond to different treatments required to recycle that specific type of plastic. Doing so actually prevents efficient recycling practices. Furthermore, recycling often yields products that are of lower quality, often preventing individuals from being interested in the recycled product. In reality, aluminum and glass products are really the only material that can be recycled to create a new product of the same stature as the parent product (Cost-Benefit Analysis, 2011). Aside from being an ineffective system, especially with regard to plastics, recycling can also have a number of negative environmental consequences.

The lower quality of most recycled products can also be accompanied by the presence of harsh chemicals that are not only damaging to the environment, but human health. For example, plastics are “downcycled” in a process that involves heavy metals both in washing of the parent material and creation of the finished product. These finished products, such as water bottles, have been known to leach said chemicals, many of which are categorized as carcinogens and have been known to disrupt the

body, especially the endocrine system (Braungart and McDonough, 2002). Regardless of the quality of the product, recycling companies often produce these chemicals as pollution that percolate into groundwater or get mixed into rainwater via smokestacks and the precipitation cycle (Cost-Benefit Analysis, 2011). The chemical outwash and pollution, combined with lower quality products, makes the process of recycling seem questionable, especially with regard to plastics.

One would wonder why recycling in its imperfect form is being championed as environmentally friendly, especially with little guidance regarding certain plastics and non-recyclable products, and that would largely be due to the impact of corporations that block the implementation of more effective, sustainable environmental policy. Not only do corporations have a large lobbying capacity with regard to regulatory matters, but they also have their hands in the pockets of environmental groups, and sit on their executive boards (Campbell, 2009). They shift the lens towards the individual and allow for processes such as recycling to create a false sense of progress. Meanwhile, industries allow themselves to remain complacent in the face of environmental crisis, by placing responsibility on the individual and municipal populations (MacBride, 2014). For example, many corporations have joined with environmental organizations in spreading the narrative that you should drive less and acquire more fuel efficient cars, rather than staying with your current model. For starters, those changes will have little impact in the grand scheme of things, and buying a more fuel efficient car can actually be more detrimental than using your old, less fuel efficient car. This is because of the massive amount of energy and resources required to make the new car, especially for hybrid cars and those touted as “green.” In most cases, the environmental cost for the

production of a new car will not offset the difference in emissions compared to your previous vehicle. While individuals can make a small difference with regard to their day-to-day behaviors, such as utilizing public transportation or walking instead of driving to work, they can make a greater difference by utilizing their capitalistic right to vote with their dollar.

If individuals that are conscious of their environmental decisions put their effort into researching and supporting companies that make sustainable decisions, it will put pressure on companies to make changes to their policies in order to become more sustainable. In other words, if consumers utilize the economic principle of “dollar voting”, we could enter a commercial age in which true sustainability and environmentalism is commercialized. Sustainability to a degree is commercialized already in our society, however, this “sustainability” targets the individual more by focusing on principles of “reduce, reuse and recycle.” This further perpetuates the illusion that individuals and corporations contribute equivalent amounts of waste. To catch onto the “green” craze, a significant portion of businesses have made products with buzz-words that don’t have actual value in terms of environmentalism. A lot of times products are falsely marketed as “eco-friendly,” when they have the same environmental impacts as other products.

> Corporations often use labels strictly as a marketing tool, “green-washing” their claims in order to reap the monetary benefits. As such, claims are not verified and the differences between legitimate programs and marketing shams are unclear to consumers. Standards not only lose their meaning, but the label and/or logo becomes inconsistent with meaning from product to product. A 2007

study by TerraChoice Environmental Marketing Inc. examined 1,753 environmental product claims and found that all but one were misleading or just plain false (Dolan et. al 2015).

That being said, if a more accurate and responsible form of sustainability catches on in corporations, it could lead to a new wave of innovation. Companies pressured to become sustainable may hire engineers specifically for the purpose of becoming greener, and then corporations may begin trying to “out-green” each other. An example of this would be products made with less fossil fuels, minimizing corporate emissions on a large scale. This emergent competitive element has the potential to align consumers’ environmental values with their purchasing behavior, in an attempt to minimize their environmental impact based on their individual consumerism (Dolan 2015). However, the competition to “out green” one another will only be realized when consumers make informed decisions that are in-line with their philosophy. If consumers are not capable of making accurate decisions because of misleading labels, perhaps it would be appropriate for the government to intervene and start making companies liable for the claims that they make on their labels.

In order for environmentalism to make serious strides towards protecting the environment and mitigating current problems, there needs to be an understanding within the movement. Regardless of perspective, people need to understand where their power lies and who is responsible for the majority of the current environmental degradation. Our current wave of environmentalism and those previously have focused too much on the individual. This focuses on day-to-day behaviors that make little

difference in the grand scheme of things. Environmentalism should instead educate individuals on how they can use their purchasing power to pressure companies into making sustainable decisions and curtail the negative actions of these entities that maximize profit at the detriment of the environment. This purchasing power would create a system of green capitalism, and allow for companies to compete over their environmental standards. Ultimately this would give rise to more sustainable products and practices and allow the environmental movement to begin to take on a more legitimate and progressive platform for protecting the environment.

Global Warming: Setting the Record Straight

Global warming is the gradual increase in atmospheric temperatures around the globe, caused by the large amounts of greenhouse emissions and the subsequently greater greenhouse effect. Greenhouse emissions are any gas that helps retain incoming solar energy, such as carbon dioxide (CO2), chlorofluorocarbons (CFC), methane (CH4) and nitrous oxide (N2O). Basically, the increased levels of the aforementioned gases act as insulation and trap incoming solar radiation, raising the global temperature.

Global warming is a subject matter that brings about great debate amongst many communities. Aside from being controversial, it's often used interchangeably with the term "climate change." Many people think the two phrases are synonymous, however, the two phrases do not mean the exact same thing. Global warming refers to the phenomenon of increased temperature caused by the previously mentioned greenhouse effect, while climate change refers to the increased variability and instability in climate compared to a historic threshold. Essentially, global warming can be a part of climate change, but climate change is not always global warming. Confusing the two is an issue because when you try to convince an audience that climate change is real, using the term global warming interchangeably can cause people to refute the scientific argument by simply saying, "global warming isn't real, it's getting colder here." And in their case, although arbitrary given natural temperature fluctuations, they could be right, because climate change will cause certain areas to get colder, not hotter (Scott, 2003).

By clarifying the difference, confusion is prevented and arbitrary arguments about cooling can be easily dismissed.

Climate Change: Causes and Consequences

As mentioned, climate change refers to a destabilizing climate in which systems become more variable and unpredictable. As a result, climate change can yield temperature fluxes, sea level rise, larger/stronger storms, droughts, etc. By changing the composition of the atmosphere via increased greenhouse emissions, the general climatic pattern changes. This phenomenon is a problem because it threatens to spiral out of control, particularly with how Arctic ice melts. The increased temperatures in the Arctic produce a number of problems such as a lack of 'old' ice. For starters, ice naturally melts and refreezes during its warm and cool season in the Arctic. The issue, however, is that melting is occurring at a faster rate during both periods, creating a net loss of ice. The ice shelf itself does refreeze, but creates a new, easier-melted form of ice. Ice that has experienced extremely cold temperatures over long periods of time forms a dense crystal structure that produces a pure white surface that reflects UV radiation back to space. Newer ice, however, doesn't have the time to compress as well and has more space between crystals, allowing for more UV radiation to penetrate through the structure and be absorbed by the ocean below. With warmer temperatures in the Arctic and higher melting rates there exists a lack of old ice, making it easier for the ice to melt every season. More melting results in more exposed ocean and therefore more absorption of UV radiation, yielding even greater temperature increases in said areas (Gow and Weeks, 1978). Increased temperatures in the northern region can also lead to melting of permafrost zones that contain methane and CO2 deposits. This in

turn causes a spike in greenhouse emissions as a result of these of the release of these deposits, and a subsequent temperature increase (Nakano et al., 2000). Ultimately, the Arctic operates on a positive feedback loop in which increased temperatures brought on by greenhouse emissions will cause temperatures to inevitably rise even more. And while most of the general public may not care about the increased temperatures and melting in the Arctic, it does have an effect on linked physical systems.

The most obvious effect of sea ice melting is sea level rise. It's projected that as early as 2050 certain coastal cities will be experiencing consistent flooding. Even today, cities such as Miami experience higher risks of flooding (Gornitz, 1991). Given projections, sea level rise will cause a significant economic toll. And in certain island nations where populations are barely above sea level, their livelihood is at stake (Webb and Kench 2010). That being said, there are other cascading effects that can come from changing the physical oceanic environment in the Arctic. For starters, the mass influx of water from the arctic could change the Atlantic Meridional Overturning Circulation (AMOC) which brings warm water north, providing Europe with its mild weather. As such, the disruption could cause extensive cooling for certain areas and change weather patterns for the northwestern hemisphere (Zickfeld et al., 2007).

Increasing temperatures also have an effect on the biota of the planet. Many organisms are susceptible to small temperature changes and can have increased mortality with temperature fluctuations. While many could care less about certain species of plants and animals, loss of biodiversity caused by species die-off will cause ecosystem instability. Ecosystem instability can directly affect humans. Humans heavily rely on their environment and constantly utilize ecosystem services for their well-being.

Ecosystem services are processes created by an ecosystem that are beneficial to humans. For example, dense forests lining stream banks act as a buffer for pollutants and prevent harmful chemicals from entering freshwater systems. With a decline in biodiversity and changes in habitat and environmental conditions, many ecosystem services will begin to disappear. With climate change threatening these environmental conditions, we as a society might lose several job fields that benefitted from the stable environmental conditions that have been enjoyed for lifetimes. For example, there are quite a few economic networks that depend on the livelihood of the ocean. If these networks are disrupted by unexpected changes, like a loss of fish caused by rising temperatures and increased acidity of the water, what happens to the livelihoods of the individuals invested in such networks? Towns built on an ocean economy that are dependent on fishing will lose their viability. This begs the question, how will a town or group of career-fishermen regain their footing in a world where their skill no longer holds any merit?

While climate change does pose a grave threat to our socio-environmental complex, there is room to mitigate its effects, slow down its progress, and inevitably return to a stable climatic state. However, reversing the negative change and current course requires immediate changes and cuts in greenhouse emissions. Greenhouse emissions are the cause of climate change and continue to exacerbate the problem (NASA, 2017). As previously mentioned, individuals need to realize their role in the mitigation of environmental issues. Specifically, individuals need to realize they make up a small portion of the large problem that is greenhouse emissions. In the United States, corporations are responsible for the majority of all greenhouse emissions. With the

current model of environmentalism focusing on individuals rather than corporations, individuals fail to hold corporations accountable for their large role in intensifying climate change.

Methodology

Timeline

Freshman year we were a part of the Huber Learning Community. This learning community focused on public health issues and revolved around the discussion of issues such as antibiotic resistance and disparities in treatment. In our associated class, we learned that antibacterial soap (particularly with triclosan as the primary antibacterial agent), were ineffective in killing organisms and promoted antibacterial resistance in microorganisms. Despite these conversations and our lectures in entry level biology classes, JMU still has several triclosan using antibacterial cleansers on campus. It seemed contrary to us that a school that educates the public about antibiotic resistance would have soap that promotes this public health issue. It was at this point that we realized that even though information and research may advise against the usage of certain compounds, or avoidance of certain strategies (i.e antibiotic agents in hand sanitizer), public policy may lag behind research. This lag between what is already known and what is being done to address the problem is one that we noticed, even as freshmen.

We recalled and reflected on this conflict between JMU's instruction and their actions as an institution. We then began wondering about other contradictory ideals and practices JMU held. From this, we started to brainstorm project topics. We were both interested in an interdisciplinary project in the hopes that it would take information from our biological backgrounds and make it more accessible to people who don't have that research background. The minority of people who are trained in biology/ecological

sciences are not enough to start a change. In order to initiate change, we sought to craft a thesis project that transcends our scientific background, allowing for a more ground-level experience. Our main motivation for a thesis project was that it would become a dynamic force, that could change public perception rather than confirming attitudes about climate change held by academics. We wanted a more dynamic project, rather than a static paper.

We then thought about how JMU promoted itself as a “green and sustainable” university, despite participating in behaviors that appeared to us as environmentally unconscious. With that in mind, we realized that many tout environmentalism and its necessity, but few truly realize its real meaning and the requirements to become “green”. Driven by this need to educate the public on the true definition of environmentalism and the perpetuation of environmentally unconscious activities by JMU, such as sprinklers on during rain storms in the spring of 2016, we came up with a project that would evaluate JMU’s “green behavior.” We wanted to investigate JMU’s sustainability policies and create a plan for making it adhere to a more accurate, environmental standard. In order to investigate and evaluate JMU’s sustainability policies, we needed guidelines and criteria that were not arbitrary or made up by us. We researched the tenets of sustainability and components of environmentally conscious actions to come up with a way to assess JMU. This led us to researching the certifying organization responsible for certifying JMU’s buildings as sustainable.

Leadership in Energy and Environmental Design (LEED), a certifying program created by the U.S. Green Building Council is the major certifying group when it comes to sustainable buildings and buildings in general. Only one of JMU’s buildings reached

the highest level of certification possible, and that is Wayland Hall. Wayland Hall is a refurbished residence hall and because it was a newer construction project, it had access to funds and technology that older buildings on campus lacked. However, it is important to note that the Student Success Center is an even newer building than Wayland hall, but it is only gold certified through LEED's certification, whereas Wayland hall is platinum certified through LEED. If the Student Success Center is newer, with access to what should be more advanced building technology, why did it score lower on the LEED certification program than the refurbishment of Wayland hall? Furthermore, despite some of our buildings being LEED certified, a great majority of the buildings on campus are out of date and also not up to bare minimum standards of LEED certification. We wondered how JMU could claim to be an environmentally forward university when it didn't even reach for the highest standards of LEED's certification with new construction efforts. While cost is usually an issue, LEED's standards tend to be easy to meet and would not require major funding differences.

This process of evaluating JMU through the lens of sustainability also got us thinking about LEED as an organization itself. The organization behind the LEED certification system sets these standards for environmentally responsible behavior. To understand LEED's standards is to understand the environmentally responsible pressures placed on American buildings. If LEED's guidelines are too slack, then it allows buildings that are in fact not environmentally friendly to pass themselves off as such. If LEED's guidelines are too strict, it runs the risk of being ostracized and ignored in favor of profit margins. We did research on sustainability and environmentalism and compared it to the LEED certification's rubric. We found that LEED buildings tended to

be more environmentally friendly than their peers, but we also found several points of interest in the LEED rubrics. These points rewarded buildings for features that didn't really make the building more environmentally friendly, such as awarding a point on the rubric for providing a bike rack, which is 2.5% of the points needed for standard certification. It was at this moment that we realized that it wasn't just JMU's environmental commitment or LEED's certifying standards that needed tweaking, but rather the current environmental ideology touted by the corporate world. Criticizing JMU's environmental commitments may be harsh at this time, because JMU is attempting to make strides that align with environmental ideologies. However, even as JMU moves forward in sustainable practices, it is imperative that we establish a new baseline for environmental behavior.

While investigating LEED, we were also interested in changing the way people think about environmentalism. Corporations release advertisements that appear to be "environmentally-conscious", while promoting individual behaviors for being "green". The politico-economic atmosphere as well as individuals seeking to absolve themselves of guilt claim that individual actions like recycling or reducing the amount of electricity used in the home will make a large difference, when in fact, when individuals are summed together they still manage to pale in comparison to corporate behavior.

We spent a semester doing research on municipal versus corporate waste production and emissions. The information we found supported our claims that corporations produce a disproportionate amount of waste compared to municipalities. However, what we kept wondering as we did research is, "will our efforts change anything? Who is our target audience?" Most of the research we did turned up

documents that were complex, and because of our scientific background we were capable of understanding that information. However, it does us little good as a society if we are consistently failing to break down important scientific phenomena such as global warming to the common populace.

Global warming is an important problem and should be considered and communicated across disciplines, not just stuck in the realm of scientists and researchers. Change cannot take place without translating the jargon and confusing nature of climate change into a simpler and more accessible format. We realized that pressuring the university to change the way they use their sprinklers (with moisture-detecting sensors), would change very little even if JMU did make changes based on our research. Despite the fact that the sprinkler use by JMU in the rain was what led us to investigate JMU's sustainability and environmentalism as a whole, it is still a mere trifle compared to the real threat of climate change. We realized that we would not only be unable to acquire sprinkler data and provide accurate results, but that we were also focusing on something so infinitesimally small in the face of current environmental problems. Because of this, we decided to shift our project from a focus on sprinklers and sprinkler usage (which is still a minor problem), to a senior project that tackled climate change from a cultural aspect instead of a physical one. We decided that instead of making a physical change, perhaps it would be time to tackle the challenge of making people our age and people who aren't scientists, care about global warming, with easily accessible facts and demonstrations.

Given our interest in producing a more down-to-earth project regarding climate change, we initially thought we would create a demonstration. To help illustrate rises in

temperature and the disparity in who's responsible for increased carbon emissions. We planned to scale down the Arctic ice sheet down to a block of ice, and then melt it based on different impacts. We came up with an arbitrary scale and suggested that we would raise the temperature by allowing people to touch the block of ice, which would promote the melting. This would be analogous to how we as individuals promote rising CO2 emissions on a municipal basis. We would then use a blow dryer of to emulate corporations and their much larger role. This touching of the ice and use of a hair dryer would symbolize how both individuals and corporations have different effects on Arctic sea ice. Arctic sea ice is more of a concern because sea ice coverage in the arctic has historically been consistent. Antarctic ice on the other hand, is seasonal. As our climate continues to get warmer, the Arctic is subject to warm summer storms that bring warm water into the area, amplifying any temperature changes that occur. Because of this, Arctic sea ice is becoming seasonal rather than consistent.

Furthermore, the Antarctic sea ice is largely determined by powerful ocean currents and the prevalence of icy winds coming off of Antarctica, rather than temperatures. For example, Antarctic sea ice has grown in the past couple of years. At this moment in time, climate change is a more serious threat to Arctic ice rather than Antarctic. For this reason, we focused on Arctic ice.

After further consideration, we realized that connecting a person's hand to the ice isn't going to convey the knowledge that we want to get across to the populace. Furthermore, arbitrarily saying that a touch represents individuals as a whole while a hair dryer represents corporate America would open up our project to intense scrutinization. Our whole point is to make it clear that corporations have the greatest

impact, and we didn't want to exaggerate effects with our demonstration. Even though temperature increase differences caused by the two are in small orders of magnitude, they still produce significant long term effects on sea ice. If we kept the kinesthetic part of our display, we risked sensationalizing the effects that we have on the Arctic ice melt. By keeping temperature in our control, we can effectively demonstrate (without hyperbole) the effect that corporate emissions have on the environment. We chose to avoid having people touch the ice to raise the temperature. Instead we chose to create scenarios. Hypothetical futures where we as a society have altered either individual or corporate emissions, which would then affect the temperatures. This would help back up our case that individuals play less of a role with regard to emissions and subsequent climate change than corporations. The scenarios would connect CO2 emissions to ambient temperatures, which is a more accurate model than the symbolism provided by our initially planned demonstrations.

We broke down the United States' emissions into corporate and municipal emissions based off of EPA information and created figures outlining each player's role in emissions. However, we ran into roadblocks with regard to modeling ice melting and the connection of temperature to emissions. For starters, we initially wanted to equate a certain temperature rise per year to the responsible party, for example a 0.01 degree Celsius increase every year due to US corporations. We also wanted to use that temperature change to determine the amount of ice melting occurring and each player's responsibility in that melting. At first, it seemed possible because of a simplified equation we found through a university math department. However, due to limitations with data and the simplicity of the equation, we got results that made no sense. This

happened because the equation was grossly oversimplified. We found a more complex model that took more into account, but it required a knowledge of higher-level calculus and an understanding of the Stefan Problem, an equation used to model the behavior of melting substances. Because of this inability to utilize the more accurate formula, we couldn't derive anything useable. So, instead of making the scenarios solely focused on individual vs. corporations, we decided to make it more broad and show the effects of increased temperature on Arctic ice, specifically relating to the idea of 'new' vs. 'old' ice. This is because newer ice has larger crystals and causes increased absorption of UV radiation.

In addition to not being able to connect a person's touch to a rise in temperature, we realized it was unrealistic to have dynamic temperature control on the external environment of an ice block, but rather it would be easier to melt it at a predetermined temperature. We want to melt it at temperatures close to arctic, because that's what melting temperatures look like in the arctic. Indoor environments would not tolerate these near freezing temperatures, so we decided to do most of our demonstrations outside in near-Arctic average temperatures for the day. Concurrently, we were looking at how individual versus corporate responsibility emissions translated to rise in temperatures and subsequent arctic ice melting.

Ice melting also had roadblocks. Given the warm 2016-2017 winter we had, temperatures were not close to what we had expected. The few times that it did get cold enough, it was too cold and below freezing for any melting to occur. Other times, the temperature sat around 40 degrees Fahrenheit and usually happened on days where we were both extremely busy. Given the erratic temperatures, we decided to do melting

events around 60 degrees Fahrenheit. While it showed nothing related to Arctic temperatures, it did show the effects of having newer ice vs older ice and the idea of having more absorption because of the darker sea beneath being seen more with the newer crystalline structure. Instead of letting it set us back, we decided that the major focus of our project would be about having discussions with people over our poster at conferences/symposiums. We used our introductory information and carbon emissions data as a platform for informing our friends, families, and community members, with the hope that they would continue to have these conversations with others, as well as understanding how best to transmit scientific information to a lay public.

Calculation of Emissions Estimates

Emissions were sorted into the four major greenhouse gases, nitrous oxide, methane, fluorinated gases, and carbon dioxide, and then scaled to their CO2 equivalent using data and information provided by the EPA. For example, certain gases have a greater greenhouse potential and are subsequently scaled to how much they would equal comparatively to CO2. Methane for example has 25x the global warming potential compared to CO2, despite its shorter lifetime in the atmosphere. With that in mind, we calculated municipal vs. corporate emissions for the four major greenhouse gases.

For nitrous oxide, the major contributors of the gas according to the EPA are agricultural soil management, manure management, transportation, industry/chemical production, stationary combustion, and 'other'. Breaking it down, with regard to manure management and agricultural soil management, the total lawn space in the United States is 163,812 km^2, and the total farm space owned by both corporations and individuals is 9,313,731 km^2. Assuming that all lawn space is owned by individuals (disregards college campus lawn space and other businesses, but we're rounding here) and given that farm space owned by only individuals is now 1,829,983 km^2, the total amount of space utilized by individuals that would be fertilized/have manure management would be 1,993,795 km^2, which when divided by the total space of 9,477,543, you get .210, or 21% of the "soil/agricultural management" being accounted for by individuals. Multiplying that .210 by the 83% of nitrous oxide emissions accounted for by manure management and agricultural soil management and you get 17.43%. The

only other categories that individuals could contribute to are transportation and ‘other’. For ease of calculations and a lack of data, we’re assuming that individuals make up half of the transportation and other emissions, which is another 3% of the total nitrous oxide emissions. While it might seem faulty to just assume half for both categories, given our knowledge of industry and corporations, we’re most likely drastically overshooting individuals’ contributions and it would be much lower. While it’s not extremely accurate and it would appear faulty to just accept the idea that individuals’ contribution would be lower, it will still portray what we’re trying to get at, as seen in our results section with our full summary of all corporate/individual greenhouse emissions. That being said, our estimates approximately model that individuals account for 20.43% of nitrous oxide emissions, with corporations responsible for 79.57%.

For methane, the major contributors of the gas according to the EPA are manure management, coal mining, landfills, enteric fermentation, natural gas systems, and ‘other’. Breaking it down, with regard to natural gas systems, residential localities and individual consumption composes approximately 18% of the natural gas usage in the US as noted by the United States Energy Information Administration. Given room for error with regard to measuring usage throughout the U.S., the 18% will be rounded up to 20%. This would mean that individuals account for 6.6% within this category (33% natural gas caused emissions x 20% individual responsibility). For the other categories, such as landfills, individuals are responsible for up to ~3% of waste compared to the staggering percentage of 97% by corporations. Given this information, the landfills category can be broken down into .64% individual emissions (20% landfill caused emissions x 3.2% individual responsibility). For manure management, we used the

same reasoning as nitrous oxide and broke down lawn space and farming land to account for individual use, using 20% as individual responsibility. In this case individual emissions accounted for 1.68% of emissions within this category (8% manure management caused emissions x 20% individual responsibility). The two categories that are estimates are “other” because it’s not specified and “enteric fermentation” which is caused by the digestion process of cows and hard to break down. Our reasoning in this case is that ‘other’ can be assumed to have at the max a 3% because of individual responsibility. For enteric fermentation, we used 5% (which we think is extremely high, but want to be safe) because a majority of livestock farming is done on an industrial scale, with small farmers selling to localities being a minority. With all this accounted for, individuals make up 16.92% of methane emissions and corporations make up 83.08% in the United States.

For fluorinated gases, the major contributors of the gases according to the EPA are substitution of ozone depleting substances, production and processing of aluminum and magnesium, semiconductor manufacturing, HCFC-22 production, and electrical transmission and distribution. While there may be some individual responsibility with regard to the “substitution of ozone depleting substances” category, we are not giving any percentage of this towards the total individual emissions sum. The substitution and use in general is because of industry’s inability to find an adequate replacement that does not have a greenhouse potential. The majority of our emissions calculations are based off the idea that while companies may make products, consumers generally use them and create emissions. However, our goal is to show that despite this usage by customers, companies still incur a lot of emissions in the manufacturing process,

transportation, and the way they conduct business in general. In this case, there are no alternative options to fluorinated gas products. For example, refrigerators can leak fluorinated gases because of their design. Assuming a consumer buys a fridge, it's not necessarily their fault because there exists no current alternative for storing food that doesn't possible leak fluorinated gases. Therefore, we gave corporations the entirety of this emissions profile and believe it will not incur too much scrutiny given that it's such a small amount comparatively speaking.

For carbon dioxide, the major contributor of the gas are residential and commercial activities, industry, and transportation. This category was more complicated to calculate because of the ambiguity of EPA's emissions data and a lack of breakdown for categories within the literature. However, given specific numbers, such as number of homes in the U.S., we came up with what we consider the most representational breakdown. For 'residential and commercial' we decided to use an average statistic by the EPA for average household CO2 emissions per year. This value encompasses what is taken into account by "residential and commercial" as well as "electricity" values. In the United States, there are 124.6 million households, producing an average of 8,049 pounds of CO2 per house. To get the emissions data we needed, we multiplied those two numbers and then divided the product by 2204.62 (pounds to metric tons conversion), yielding an individual emissions value of 454,740,684 metrics tons for those two categories. Considering industry is synonymous with corporations, the only other category we had to account for was "transportation." While we don't know the exact breakdown, we decided to just half the percentage. This estimate is most likely exaggerated for individuals, but we wanted to make sure that we weren't cutting

individuals any slack by having estimation bias. With that in mind, individuals are responsible for 15.5% of the transportation category. All together, individuals account for 23.2% and corporations account for 76.8% of carbon dioxide emissions.

Taking into account the four main types of greenhouse gases, nitrous oxide, methane, CO2, and fluorinated gases, the United States' produces the most greenhouse emissions in the world per capita. For the entire emissions profile, individuals were given approximately 22% and corporations 78% of all CO2 equivalent emissions.

Ice Melting

Ice was created by putting nine cups of water into one gallon ziploc storage containers and freezing them in a standard freezer at the same temperature, right next to one another. One of the two containers had the bottom spray painted black to emulate new ice and the idea that more of the subsurface or ocean can be seen because of the more loose crystalline structure. After 48 hours, the containers with ice were set in the ice bath emulating the current seawater conditions in the arctic. This was done by adding 1500 grams of salt to 50 liters of water in a large plastic container kept outside, to create 30 parts per thousand salinity, which is the same salinity as the arctic ocean. Before placing the containers in the seawater bath, the bath was left outside in sub/near freezing temperatures to get the temperature of water near 30 degrees Fahrenheit, the average temperature of Arctic sea water. The container was also positioned outside on the deck to maximize sunlight reaching both containers.

On the first attempt, the ice was accidentally stacked because one of our roommates moved the blocks, which deformed the shape of one of the ice blocks in the containers. Instead of scrapping it, it was used as a test run to determine the average time it would take to melt the ice at the given temperature. For the trial run, the ice was melted at 35 degrees Fahrenheit.

For the rest of the melting events, the water amount that was frozen was lowered to 6 cups because of the time it took to melt the ice in the test trial. Also, the containers remained side by side during freezing, preventing any disfigurement of the containers.

As mentioned, the weather was not cooperative and melting had to occur near 60 degrees Fahrenheit. Pictures were taken every 15 minutes to monitor the melting.

Infographic

For the infographic that was created, the idea was to make something relevant to the common public. Often times, environmental groups will use the polar bear as their message for climate change. Basically, these groups are trying to get people to empathize for these animals by saying that climate change is going to ruin their home and that they're going to go extinct.

This appeal to pathos however only works if these people care about the animal at hand. Many people don't care about polar bears or any other wildlife enough to be brought to action on the polar bear's behalf. Polar bears are not part of the average citizen's daily routine, and thusly their importance and impact is not understood by the lay public. So instead of utilizing the distant image of a polar bear stranded on an ice block floating in the ocean, we decided to show people how climate change could directly affect their livelihood.

Climate change skeptics often mention that climate change cannot be real because they are still breathing (because carbon dioxide is not breathable). In other words, they are reluctant to believe the threat of the problem while it is still in a manageable phase. This misconception is most likely linked to the idea that increased carbon dioxide levels in the atmosphere would theoretically choke people out. While this may sound absurd to most scientists, as you would need a ridiculous amount of carbon dioxide in the atmosphere to actually prevent breathing, it is how people understand what they are being told. And while that justification for lack of breathing is not true,

climate change does in fact bring with it the possibility of increased death by cardiorespiratory problems. As scene in the infographic, the whole process is broken down into a simple image that helps the public understand the looming threat of ground level ozone, or smog.

The infographic itself utilizes a simple vocabulary and lacks any complicated data that will scare lay individuals away. It is kept cartoon-like and vibrant to entice people to read, while maintaining a darker surface to illustrate the threat still posed by climate change. In this manner, the infographic conveys the information, gives a simplified image of what will happen, and connects individuals to the real threats that will be experienced by a changing climate.

Results

Emissions Breakdown

Taking into account the four main types of greenhouse gases, nitrous oxide, methane, CO2, and fluorinated gases, the United States produces the most greenhouse emissions in the world per capita. All in all, the United States produces a total of 6.91 billion metric tons CO2 equivalent emissions each year. Given previous calculations, responsibility for emissions can be broken down for each gas into municipal and corporate. For carbon dioxide, municipalities are responsible for roughly 23%, while corporations are responsible for 77%. For nitrous oxide, it's approximately 20% and 80% respectively and for methane it's approximately 17% and 83% respectively. Finally, mostly all of the fluorinated gas emissions can be attributed to corporations and their faulty practices. Given these numbers and the sums of all CO2 equivalent emissions, municipalities are responsible for approximately 22%, with corporations being responsible for roughly 78% (Figure 1). That equates to 1.5 and 5.4 billion metric tons respectively.

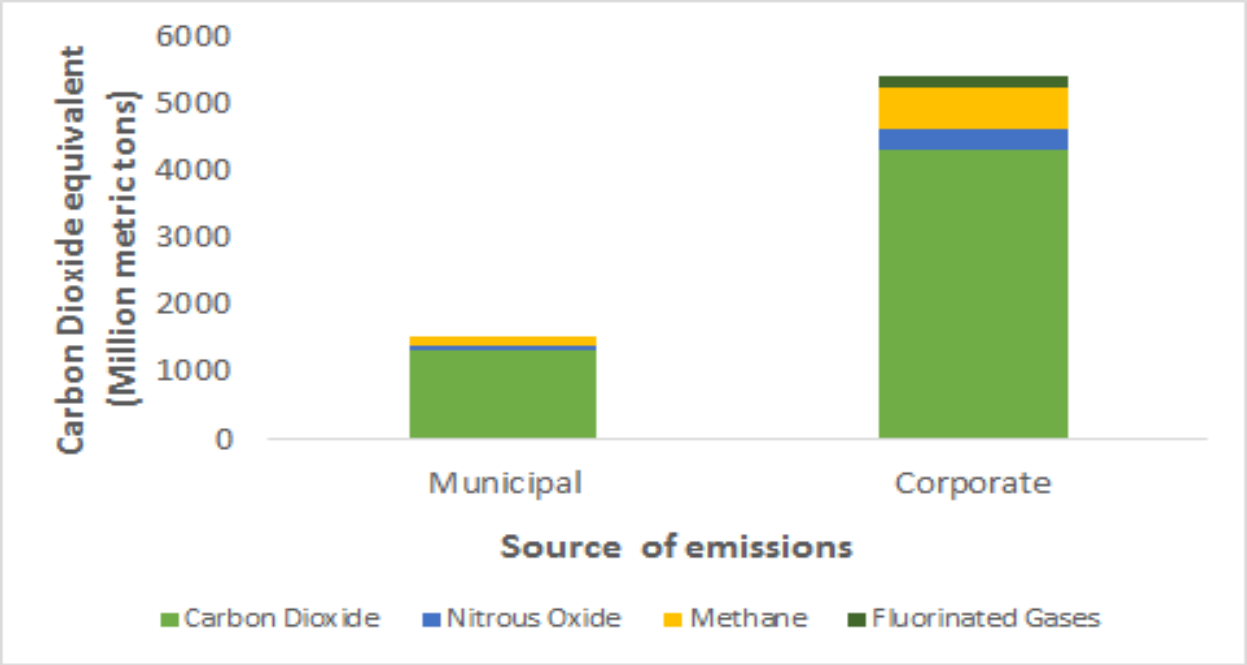


Figure 1. Different types of greenhouse gas emissions converted to CO2 equivalencies and broken down into the source of their emissions. Data was acquired from the EPA and subsequently broken down into their source based off the EPA's information.

I*ce Melting*

For the test trial, the ice took over six hours to melt. Given that it was a test trial, it was decided that it would be ended early and subsequent, real trials would be conducted with less ice.

The two trials that were completed took on average around 4 hours. The first trial took 233 minutes for the ‘new’ ice (painted black bottom) and 265 minutes for the ‘old’ ice (no coloring on the bottom). The second trial took 238 minutes for the ‘new’ ice and 276 minutes for the ‘old’ ice. Melting was observed to be more rapid for the ‘new’ ice once the bottom of the container was more exposed (Figure 2).

Figure 2. Two ice melting trials, with the first being the left column and the second being the right. The rows represents 15 min, 60 min, and 180 minutes from top to bottom, respectively. Trial one was melted at an average of 63 degrees Fahrenheit with sunny conditions and trial two was melted at an average of 62 degrees Fahrenheit with sunny conditions.

Discussion

Ice Melting

We understand that, at face value, the ice melting portion of our project seems to be nothing more than a glorified experiment demonstrating that darker substances absorb more heat. The crystallization composition was not calculated, Arctic temperatures could not be emulated, and our supply of equipment was limited. However, while it was grossly oversimplified and could have been conducted in a better manner, the general idea of the test had merit. The experiment itself succeeded in demonstrating that if new ice has larger ice crystals, like many of the sources we found say, then it would melt faster than older ice. That being said, the difference in rate of melting was exaggerated in our case and has no use with regard to use for public interface.

Assuming someone has the capacity to quantify difference in crystalline structure and emulate temperature differences, this experiment could be recreated for public use and would be beneficial in explaining the effects of temperature on Arctic ice. What we know for a fact is that areas with “new ice” melt faster than areas with “old ice”. The difference in crystalline structure is a hypothesis for why this phenomena occurs. While we did not get around to doing a large-scale demonstration, it would be useful, as people tend to visualize the problem better when it is right in front of them. With funding and more resources, a large-scale ice melting demonstration in front of people could be constructed to demonstrate the magnitude of the arctic ice sheet, as well as help lay audiences understand the importance of its loss.

Emissions

Climate change remains one of the biggest environmental problems of our time. Understanding the nature of emissions, which types of gases contribute to climate change, and how these gases are produced by municipalities and corporations is critical to moving forward in controlling the scope of climate change. A main component of our project was focused on determining how vast the difference is between municipalities and corporations with regard to emissions.

Our breakdown included utilizing resources such as EPA data, total number of homes in the U.S., the average energy expenditure per household, etc. However, in the end, a majority of the numbers in the breakdown were based off of estimates made by the two of us from the EPA data. Estimations, while not exact, can still provide a significant amount of information. With the large difference between municipal and corporate emissions found in our estimate, along with the fact that we estimated conservatively on corporate emissions, it is possible that corporations play a much more significant role in emissions. Despite this, they have been largely unchallenged by the environmental movement and people who consider themselves environmentalists. Indeed, these people focus on small-scale individual behaviors rather than assessing and understanding the impact that their support of certain corporations has on the environment.

Doing some simple math, one can see that placing a greater emphasis on corporations and their emissions can have a much greater mitigation effect. As mentioned, while our numbers are estimates, they do provide a good framework to work within. For example, reducing corporate emissions by 25% could have approximately

the same effect as making all individual emissions zero. This is an impossible feat. While greater percentage cuts would increasingly provide far fewer greenhouse emissions, it's best to not throw out radical numbers when discussing initial plans for reduction/regulation, because even 25% would cause certain groups to turn away or lobby against the efforts.

Our ecological/carbon footprints go beyond our individual behaviors, past turning off the lights or recycling a soda can and extend into our purchasing patterns and the companies that we support with our financial decisions. With a focus placed on individual emissions, we as a society fail to actually solve the problem of greenhouse-gas-driven climate change. We instead have focused on a minor player in the problem, rather than confronting the major player in corporations. Further environmental efforts should perhaps focus more on the relationships between individuals and corporations. Exposing corporate emissions and shifting the lens of blame toward companies and their unsustainable practices will allow for a more legitimate chance at climate change mitigation, as well as positive environmental change overall. However, there is an important distinction. We are not advocating for individuals to give up their "green" behaviors. Rather they should continue to practice these environmentally conscious behaviors within their day-to-day behavioral networks as well as in their larger, broader communities. For example, an individual can continue to work towards minimizing their light usage within their apartment, all the while joining a network of individuals that boycott companies that use palm oil as an additive. Doing both will increasingly move us forward towards lowering greenhouse emissions as a country.

Maintaining Relevancy

Environmentalism in its current wave/state is flawed. It places a significant amount of emphasis on the individual as the major perpetrator and does not necessarily take into account corporate greed and those responsible for large-scale environmental degradation. We propose that individuals begin to view themselves as powerful as they are, entities that control the inevitable fate of corporations based off their sustainability record. And to clarify, when using the world sustainable with regard to behaviors, we mean practices that do not have a lasting or severe impact on the environment and which can be repeated over a long period of time without consequence. By focusing on the relationship between individuals and corporations, individuals can feel empowered and find a connection to sustainable behaviors.

With this in mind, environmentalism must reorganize to overcome a major barrier to environmental health; the current model of capitalism. Capitalism at its core promotes doing whatever possible to increase profits. Unfortunately, doing awful things to the environment is the norm for increasing profits in today's economy. Transforming capitalism into a more environmentally responsible system is going to take significant efforts, and our research alone cannot provide an answer for this economic system. However, what our research can say with confidence, is that environmentalism and capitalism do not necessarily have to oppose each other. Rather, capitalism needs to recognize sustainable constraints. While capitalism in the United States at the moment does not consider the health of the environment in the face of profit, there is a possibility for a green capitalism to emerge. One that considers profit as well as the upkeep and maintenance of the environment through conscientious use of resources. One could

imagine a capitalism in which green practices and products (real green, not false advertising) were competed over for the benefit of the environment and the consumer. For example, perhaps in some distant future all items are either biodegradable or able to be recycled without giving up quality of the product. While at its core, capitalism is a threat to sustainability, it is unlikely for America to embrace environmentalism if it means abandoning capitalism as a whole. It is more likely that environmentalism will be utilized by America if we as consumers begin making environmentalism a priority.

Moving forward is difficult. Change is hard for a society that is not mindful of its potential impacts. We must start by simply acknowledging that there is a problem with the current system and that changes need to be made to the environmental movement. There needs to be more social awareness surrounding environmental issues and the movement in general. Too few people identify as environmentalists. That being said, if positive change can occur and we begin to progress, we must also recognize our previous failures and reflect on what is working, what is not working, and flaws in our motivations. At this stage in the climate change crisis, we are too late to reverse our damage to this environment. This irreversibility should not be an end sentence and should not discourage us from making positive changes towards sustainable practices.

It should be noted that previous discussion within this section has focused on the environmental movement as a whole, while we were specifically looking at climate change for this project. We took a step back and looked at it from a broader scale because of the fact that revitalizing our current wave of environmentalism will have trickle down effects for climate change and its mitigation. With that in mind, the

movement, specifically relating to climate change mitigation, needs to abide by a few commandments to maintain its relevance across diverse populations.

When it comes to climate change communication and subsequent mitigation by public involvement, scientists and people working within the environmental movement must follow what we believe to be four important tenets. For starters, there should always be a local component to problems created by climate change, otherwise people are not connected to the issue. For example, an individual living in Pittsburgh, Pennsylvania could care less about sea level rise and disappearing islands in the Pacific. It does not affect them. Perhaps they will have a passing thought, but for the most part, in their mind, it has nothing to do with their life. However, if you make the problem of climate change relevant to Pittsburgh, and say increasing temperatures will increase smog, which will affect your health long term, this individual will be more motivated into action. Furthermore, this local spin should involve a two-way communication, allowing for individuals to ask questions and have a dialogue with science.

Overall, climate change communicators are tasked with the difficult issue of what we believe to be a second tenet, communicating the threat with seriousness without sounding apocalyptic. Yes, climate change brings with it major threats to society and infrastructure, but it does not need to be portrayed as an unsolvable issue with inevitable death for everyone. Climate change is not going away and we need to be adaptable. Unfortunately, making apocalyptic claims causes paralysis in society. To fight this issue, society needs to feel empowered and not helpless. People lose touch

with the problem when they feel like the problem is unsolvable or too grave. By creating a positive, but realistic frame of discussion, change can happen.

A third tenet necessary for successful public engagement regarding climate change is the idea of changing the communication framework. Too often environmental organizations or groups tout similar images of polar bears dying because of a loss of their habitat or a stranded bear on an ice block floating in the ocean. While this might shock ecologists into action, it generally will not motivate the general populace. Environmentalists have to understand that not every person has the capability to care about biodiversity loss and threatened species unless that is tied directly back to that person's livelihood. Furthermore, continually reusing the same imagery reduces the emotional impact. People begin to realize that there are still polar bears, and from their angle, it appears like nothing is changing. Similar to the "keep it local'" tenent, changing the climate change communication framework must have a connection with people. It also has to diversify its imagery and what it is saying. In order to connect with and influence as many individuals as possible, the pathos appeal through which climate change communicators engage society needs to be variable and multifaceted. This change will make people understand the threats that climate change places on their livelihood directly.

Much like changing the communication framework, the final tenant would be to have an interdisciplinary team when addressing problems associated with climate change. Having a diverse group of perspectives from different disciplines allows for creative, well-rounded decision-making that transcends unilateral solutions. It creates an environment in which things that would not have been thought about in other

settings, are thought about. And additions to groups are endless; you can always add another perspective. For example, if you have a group of scientists trying to address and trash and pollution within the area and study its effects on river chemistry and wildlife, one might consider a biologist and chemist. However, a psychologist or sociologist might provide a glimpse into why that area is experiencing increased levels of dumpage. A city worker or garbage disposal agent could help discuss the local mindset of corporations that dump pollution in that area as well. Maybe there is a lack of access to dumpsters within the area and the river is an easy method for getting rid of waste. By pulling as many relevant people as possible into the situation and getting their perspective, you are more likely to make an educated decision that fixes the issue without compromising the interests of all involved.

Future Work

This project sought to understand the complex relationship between science and society, specifically focusing on climate change and the faulty perceptions individuals have regarding the problem. While most of the information we acquired was new to us and we learned a lot about public perceptions, we failed to actually connect our research to the larger community. We had conversations with friends, families and individuals at conferences, and we made our information less technical, but we still never got out into the community and surveyed the public or asked large populations what they thought of our process and what we believe to be true. With this in mind, we recommend that in the future someone connects our research and more edified data to the public sphere. Perhaps a future project may survey the diverse communities present in our locality.

For instance, James Madison University, Harrisonburg, and Rockingham County represent different communities, all with their own unique, identifiable values, beliefs, and behaviors. It would be interesting to survey individuals from all three communities and see how people's perception of climate change differs between communities. For example, a majority of Rockingham County is composed of farms. Farmers, while simply trying to make a living, are taking part in practices that are environmentally damaging, such as overuse of fertilizers or mono-cropping. It would be ignorant of us or the environmental movement to assume that these individuals would be willing to make changes by telling them that they are committing harm against our planet. Perhaps if framed differently, they would be willing to make changes that were more sustainable

long term. Just because they are taking part in these practices does not necessarily mean that they are anti-environment.

It would also be intriguing to compare the general beliefs of farmers to the attitudes of Harrisonburg city residents, who do not farm and probably hold different opinions. On the flip side, if people are truly not cognizant of climate change or resistant to believing in it, there needs to be a way to reframe the issue to include them or influence their opinion. In other words, if there was a survey conducted, a goal could be to find a way to not only gather information, but also to use as a tool for cultivating a dialogue that allows for the multitude of communities to come together and create positive change. JMU would be integral in facilitating this change, as it lies at the crossroads of the county and city. Students are consistently present in the community. Working jobs or volunteering, they pick up on the opinions of different groups and could find creative ways to bring everyone to the same table.

As previously mentioned, our project didn't reach as big of a population as we would have wanted. With that in mind, we recommend that if a future survey is done, the individuals in charge test methods for interacting with the public and reframing the message of climate change. Our success story, although small, was Josh's conversation with his family.

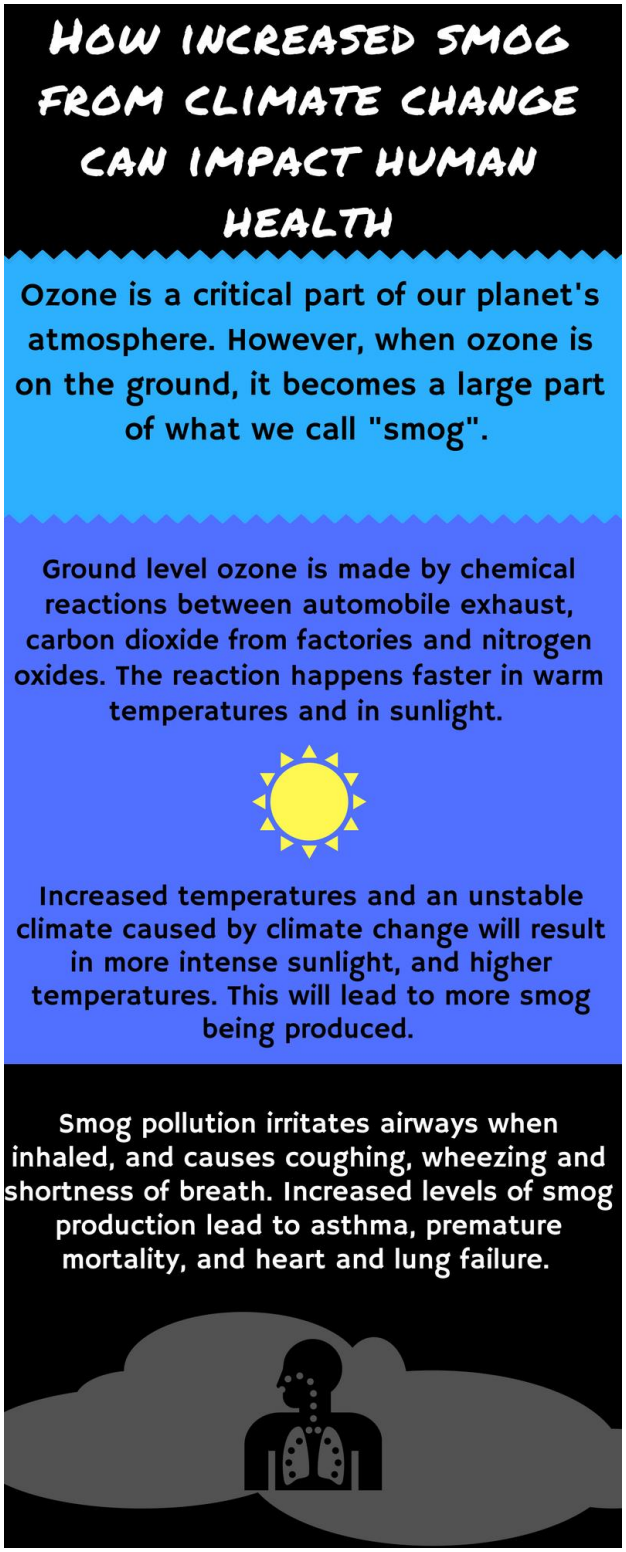
Josh comes from a family of climate change skeptics/deniers and those who firmly believe in Christianity. The religion is mentioned not to shame or call out a certain religion, but to develop the background for Josh's family. When he tried convincing his family as a whole, he consistently ran into the issue of religion. His family believed that

God would save us and that problems such as climate change would not affect humans because of God's protection.

However, instead of becoming combative, he reframed the idea of religion. Christianity and the Bible preaches environmental stewardship. By explaining the idea that we are polluting our planet and connecting it to the religious component, Josh was able to convince his dad that climate change is not some political debate, but rather, a scientific issue rooted in evidence.

In the end, climate change is a major threat to our society. Near and far, all will inevitably be affected by this environmental issue. It is on us to find creative ways to engage skeptical populations, solutions to large-scale emissions, and ways to mitigate and prepare for this looming problem. While our project did not find a clear answer to any of the aforementioned predicaments and had multiple setbacks, we did come to understand the complex nature of environmental problems and the massive effort that needs to gain traction before anything truly gets done. Our current social, political, and economic system appears to be rooted in fossil fuels and unsustainable practices, with no end in sight. However, scientists and the public need to continue doing work to combat these entrenched practices, recognizing the possibly of continued failure with short glimpses of success.

Appendix A


How increased smog from climate change can impact human health
Ozone is a critical part of our planet's atmosphere. However, when ozone is on the ground, it becomes a large part of what we call "smog".
Ground level ozone is made by chemical reactions between automobile exhaust, carbon dioxide from factories and nitrogen oxides. The reaction happens faster in warm temperatures and in sunlight.
Increased temperatures and an unstable climate caused by climate change will result in more intense sunlight, and higher temperatures. This will lead to more smog being produced.
Smog pollution irritates airways when inhaled, and causes coughing, wheezing and shortness of breath. Increased levels of smog production lead to asthma, premature mortality, and heart and lung failure.

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